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Original communication

Analyses of odontometric sexual dimorphism and sex assessment accuracy on a large sample

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ABSTRACT

Correct sex assessment of skeletonized human remains allows investigators to undertake a more focused search of missing persons' files to establish identity. Univariate and multivariate odontometric sex assessment has been explored in recent years on small sample sizes and have not used a test sample. Consequently, inconsistent results have been produced in terms of accuracy of sex allocation. This paper has derived data from a large sample of males and females, and applied logistic regression formulae on a test sample. Using a digital caliper, buccolingual and mesiodistal dimensions of all permanent teeth (except third molars) were measured on 600 dental casts (306 females, 294 males) of young adults (18–32 years), and the data subjected to univariate (independent samples' *t*-test) and multivariate statistics (stepwise logistic regression analysis, or LRA). The analyses revealed that canines were the most sexually dimorphic teeth followed by molars. All tooth variables were larger in males, with 51/56 (91.1%) being statistically larger ($p < 0.05$). When the stepwise LRA formulae were applied to a test sample of 69 subjects (40 females, 29 males) of the same age range, allocation accuracy of 68.1% for the maxillary teeth, 73.9% for the mandibular teeth, and 71% for teeth of both jaws combined, were obtained. The high univariate sexual dimorphism observed herein contrasts with some reports of low, and sometimes reverse, sexual dimorphism (the phenomenon of female tooth dimensions being larger than males'); the LRA results, too, are in contradiction to a previous report of virtually 100% sex allocation for a small heterogeneous sample. These reflect the importance of using a large sample to quantify sexual dimorphism in tooth dimensions and the application of the derived formulae on a test dataset to ascertain accuracy which, at best, is moderate in nature.

1. Introduction

Accurate sex prediction is perhaps the most important step in post-mortem reconstructive identification of skeletal remains since it excludes approximately half of the population. This allows investigators and law enforcers to undertake a more focused search of the missing persons' files, and a potentially swift recovery of ante-mortem records. Biological analysis of hard tissues is shown to produce virtually 100% accurate sex identification.[1,2] However, it is not uncommon for investigative agencies to advice against invasive procedures that result in destruction of evidentiary material, thus necessitating the use of anthroposcopic and/or anthropometric parameters.

In the skeletal system, the pelvis is shown to be the most accurate indicator of sex, and is known to produce 100% or near-100% accuracy.[3–5] In addition, craniofacial and mandibular features are also recommended to differentiate males from females.[6–8] The teeth take prominence when other skeletal parameters are unavailable, owing to the latter being missing or fragmented. And that is a major advantage of the teeth – since they are the strongest structures in the human body, and also because humans have a

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complement of 32 teeth, at least some teeth are recovered from skeletonized remains. This, as well as their applicability in non-adults, encourages continued research on odontometric sex assessment.

In recent years, great interest has been generated in determining the usefulness of teeth in sexing populations from South Asia, a hitherto unexplored region. These studies, primarily from Nepal and India, have applied univariate and multivariate statistics and obtained moderate to high levels of accuracy in sex identification.[9–14] In particular, a recent paper that applied logistic regression analysis found virtually 100% success in differentiating males and females.[14] A possible drawback to the conclusions drawn in these papers[9–14] was the usage of what may be considered as 'minimal' sample size.

The present study has ventured to examine a larger sample to quantify sexual dimorphism and potentially verify previous inferences. Also, the objective was to develop logistic regression equations on the large sample for application in sex prediction in routine forensic casework, and determine their accuracy on a test sample – an approach not followed in previous odontometric sex assessment studies.[11–13,15–17]

2. Methods

The sample comprised of 669 dentitions derived from 323 males and 346 female subjects in the age-group of 18–32 years. Participants were undergraduate and graduate students enrolled in, and faculty members employed in, two dental schools in South-western India, and the general population from a South-east Indian state. The sample was limited to young adults so as to ensure that the dentitions were fairly intact, free of pathology and wear, ensuring that tooth measurements obtained were from relatively unworn and healthy teeth, reflecting 'unaltered' anatomic data. The student and faculty population ($n = 469$) originated from 18 of the 29 states of India, and were drawn from different ethnic groups, castes and religious affiliations; the rest ($n = 200$), although derived from a single South-eastern Indian state, was also heterogeneous in nature representing multiple ethnic, caste and religious groups, similar to the pan-India population described above. Following informed verbal consent, alginate impressions were made of the subjects' dentitions (as per manufacturer's instructions) and the casts poured in dental stone.

The mesiodistal (MD) and buccolingual (BL) dimensions of all teeth, excluding third molars, were measured on the casts using digital calipers sensitive to 0.01 mm (Mitutoyo Corp., Kawasaki, Japan; Altraco Inc., Sausalito, USA). The MD measurements were defined as the greatest dimension between the contact points on the proximal surfaces of the crown, measured with the caliper beaks placed occlusally along the long axis of the tooth.[16,18] When teeth were rotated or misaligned, measurements were taken between points on the proximal surfaces of the crown where it was considered that contact with adjacent teeth would normally have occurred.[18] Although this definition was followed diligently, the measurements obtained were, in effect, the maximum extent of practical access by the caliper, which may not necessarily coincide with the anatomical crest of curvature on the tooth surfaces. The BL measurements was defined as the greatest distance between the labial/buccal surface and the lingual surface of the tooth crown, measured with the caliper beaks held at right angles to the MD dimension described above.[16,18]

In each subject, 56 tooth variables (14 MD and BL dimensions each in the maxilla and mandible) were measured. The measurements were obtained by three observers, each on 125 (observer I), 200 (observer II) and 344 casts (observer III), respectively. All observers were trained oral anatomists and accomplished in the nuances of tooth morphology. None had any knowledge of the demographic information of the subjects, including sex, at the time of tooth measurement. The observations were obtained separately from three different locations and, consequently, the measurements between the observers were not calibrated and the teeth were measured based purely on the definitions in the preceding paragraph. According to Mincer et al.[19] the use of multiple observers introduces greater variability into the measurements than if differences in judgement were the result of just one observer. However, such an approach was intentional since, like Mincer et al.,[19] we too wanted to incorporate some degree of inter-observer variability that may be produced in tooth measurements obtained by specialists. This approach attempted to address the practicalities of forensic casework wherein examiners who rely on published standards in their casework are themselves not necessarily calibrated to the measurements of the observers who generated the formulae, but are trained dentists/oral anatomists/anthropologists, and would invariably rely on the definitions given in the literature. In a sense, the incorporation of inter-observer variability may be considered as a pragmatic approach, and has previously been employed in a noteworthy forensic dental age estimation study.[19]

The casts were divided into a reference sample of 600 (306 females, 294 males), and a test sample of 69 (40 females, 29 males). The reference and test samples included casts measured by all three observers although the contribution of observer I to the test sample (29%) was proportionately more than his contribution to the reference sample (17.5%), while the opposite was true for observer III (43.5% of test sample vs. 52.3% of reference sample). Potential univariate sexual dimorphism in the reference sample was assessed applying the independent sample's t-test. Stepwise logistic regression analysis (LRA) was undertaken on the reference sample to derive logistic regression formulae. In the last decade-and-half, LRA has gained increased usage in sex assessment studies[14,20–23] and is recommended over other multivariate statistics, such as discriminant function analysis, owing to a number of advantages (e.g., it can handle discrete *and* continuous variables, and can produce a probability of sex allocation).[24] A stepwise procedure was undertaken in order to select the best tooth variables for sex determination. As noted by Potter,[15] every tooth variable "may not necessarily be useful in discriminating between the sexes. Therefore, we should find out which of the original 56 variables contribute significantly" to sex assessment (p. 716).

The logistic regression formulae were derived taking into consideration availability of both jaws or a single jaw, as may be encountered in forensic casework. Albanese[21] suggests four important approaches to assess the fit of a logistic regression formula to the data: (1) calculation of the allocation accuracy of the formula when applied to the sample used to develop the formula; (2) a histogram of probabilities of the sample; (3) a goodness of fit statistic represented by the −2 log likelihood (−2LL); and (4) calculation of allocation accuracy for a hold-out or test sample not used to develop the formula. We believe that approach (4) is the most useful and unbiased since it allows one to gauge possible accuracy rates, or the frequency of sex identification, in forensic casework. The formulae were, therefore, tested on the 69 casts designated as the test sample. From an academic interest, the accuracy rates of sexing the test sample were compared to approach (1), which was generated during the stepwise LRA.

Although data obtained from the three observers were pooled, potential intra-observer difference was assessed to determine the feasibility of a single observer being able to repeat his/her measurements at two points in time (as is necessary in real-life scenarios). To this end, measurements were repeated by each observer after a span of approximately three months: 20 casts by observer I, 30 casts by observer II, and 20 by observer III. The paired samples' t-

test was applied to determine statistical congruence, or the lack of it, for the repeat evaluations within each observer. All statistical analyses were performed on the SPSS 10 software program (SPSS Inc., Chicago, USA; now IBM Corp., Armonk, USA). The sex identification of the test sample was undertaken on an MS Excel spreadsheet (Microsoft Office 2007, Microsoft Corp., Redmond, USA).

3. Results

3.1. Intra-observer variation

The paired samples t-test that assessed potential differences in repeat measurements of the teeth revealed high intra-observer concordance and statistically insignificant differences ($p > 0.05$) in the repetitions of all three observers. The exception to this were the BL dimension of the maxillary right first molar (tooth 16) and MD dimension of maxillary left lateral incisor (tooth 22) for observer I, BL of maxillary left central incisor (tooth 21), MD of maxillary right central incisor (tooth 11), maxillary and mandibular left second premolars (tooth 25 and 35, respectively), mandibular left first premolar (tooth 34) and right first molar (tooth 46) for observer III. The differences ranged up to 0.12 mm for observer I, and up to 0.10 mm for observer III.

3.2. Univariate sexual dimorphism

All tooth dimensions were bigger in males and the independent sample's t-test showed that 51 out of the 56 measured variables (91.1%) were statistically larger in this sex (Table 1). The MD dimension of the mandibular right canine (tooth 43) exhibited the greatest sexual dimorphism, followed by MD of the mandibular left canine (tooth 33), BL of the mandibular right canine (tooth 43), and BL and MD of the maxillary right canine (tooth 13). Overall, all MD and BL dimensions of the canines (eight measurements) were part of the nine most sexually dimorphic tooth variables. Other notable sexually dimorphic measurements were BL dimension of the maxillary right and left first molar (teeth 16 and 26), while the BL dimensions of three second molars followed (Table 1). A tooth-wise analyses revealed that canines were the most sexually dimorphic teeth, with an average t-value of −8.56 (calculated from Table 1), followed by the second molars (−6.11), first molar (−5.90), first premolars (−4.33), lateral incisors (−3.48), second premolars (−3.45) and central incisors (−3.38). The maxillary tooth dimensions (average t-value = −5.08) were slightly more sexually dimorphic than the mandibular tooth dimensions (−4.98); BL dimensions (average t-value = −5.76) were recognizably more sexually dimorphic than the MD measurements (−4.30).

3.3. Accuracy of stepwise logistic regression formulae

The results of the stepwise LRA are depicted in Tables 2 and 3. These include the tooth variables that entered the stepwise analysis, the respective coefficients, and the constant for each formula in Table 2; the allocation accuracy of the stepwise logistic regression formulae obtained by its application on the sample that was used to develop the formulae [$n = 600$; 'approach (1)'] revealed an overall correct sex identification of 74.8% when teeth from both jaws were used (Table 3). This reduced to 68.8% using only maxillary teeth but increased to 74% for mandibular teeth. Females were identified more accurately than males for all three formulae (Table 3). The accuracy of the stepwise logistic regression formulae on the test sample [$n = 69$; 'approach (4)'] is also depicted in Table 3. A correct sex identification of 71% was obtained using the formulae for both jaws, which decreased to 68.1% for maxillary teeth but increased to 73.9% for mandibular teeth. Again, females were identified more accurately using the formulae for both jaws combined and for maxillary teeth; however, the accuracy in females was lower than in males for mandibular teeth.

Table 1
Descriptive statistics and t-values of MD and BL dimensions in Indian female and male teeth.

	Females ($n = 306$)		Males ($n = 294$)		t-value	p
	Mean	S.D.	Mean	S.D.		
MD11	8.38	0.59	8.58	0.57	−4.217	0.000
BL11	6.76	0.67	7.06	0.72	−5.241	0.000
MD12	6.64	0.64	6.81	0.64	−3.111	0.002
BL12	5.97	0.73	6.25	0.70	−4.822	0.000
MD13	7.51	0.48	7.84	0.51	−8.126	0.000
BL13	7.49	0.61	7.93	0.68	−8.457	0.000
MD14	6.89	0.48	7.05	0.50	−4.111	0.000
BL14	9.07	0.55	9.30	0.57	−5.033	0.000
MD15	6.58	0.57	6.68	0.47	−2.403	0.017
BL15	9.01	0.60	9.26	0.55	−5.31	0.000
MD16	10.09	0.57	10.29	0.55	−4.433	0.000
BL16	10.79	0.55	11.16	0.57	−8.015	0.000
MD17	9.49	0.75	9.83	0.73	−5.674	0.000
BL17	10.62	0.71	11.01	0.65	−7.133	0.000
MD21	8.37	0.57	8.56	0.58	−4.122	0.000
BL21	6.80	0.74	7.03	0.73	−3.75	0.000
MD22	6.68	0.62	6.76	0.60	−1.619	0.106
BL22	6.00	0.76	6.25	0.73	−4.145	0.000
MD23	7.47	0.43	7.77	0.50	−7.854	0.000
BL23	7.51	0.64	7.94	0.66	−7.924	0.000
MD24	6.94	0.44	7.07	0.50	−3.428	0.001
BL24	9.03	0.55	9.29	0.57	−5.676	0.000
MD25	6.56	0.48	6.63	0.46	−1.676	0.094
BL25	9.02	0.55	9.25	0.59	−4.959	0.000
MD26	10.19	0.61	10.37	0.65	−3.479	0.001
BL26	10.78	0.58	11.12	0.59	−7.261	0.000
MD27	9.54	0.74	9.83	0.73	−4.756	0.000
BL27	10.61	0.68	10.96	0.86	−5.573	0.000
MD31	5.36	0.48	5.39	0.40	−0.933	0.351
BL31	5.55	0.60	5.74	0.64	−3.896	0.000
MD32	5.83	0.39	5.96	0.44	−3.924	0.000
BL32	5.80	0.59	5.96	0.64	−3.281	0.001
MD33	6.51	0.43	6.84	0.46	−8.976	0.000
BL33	6.77	0.58	7.19	0.70	−7.88	0.000
MD34	6.98	0.43	7.05	0.48	−1.997	0.046
BL34	7.61	0.47	7.88	0.55	−6.474	0.000
MD35	7.06	0.61	7.11	0.48	−1.1	0.272
BL35	8.21	0.56	8.45	0.61	−4.985	0.000
MD36	10.67	0.60	11.00	0.61	−6.695	0.000
BL36	10.21	0.53	10.52	0.57	−6.84	0.000
MD37	9.88	0.70	10.19	0.66	−5.446	0.000
BL37	9.76	0.70	10.13	0.60	−6.881	0.000
MD41	5.35	0.43	5.41	0.37	−2.004	0.046
BL41	5.58	0.63	5.73	0.67	−2.882	0.004
MD42	5.82	0.39	5.94	0.41	−3.654	0.000
BL42	5.90	0.60	6.07	0.67	−3.272	0.001
MD43	6.47	0.40	6.84	0.45	−10.689	0.000
BL43	6.74	0.61	7.19	0.69	−8.542	0.000
MD44	6.96	0.46	7.03	0.50	−1.824	0.069
BL44	7.59	0.50	7.85	0.56	−6.074	0.000
MD45	6.97	0.50	7.09	0.54	−2.816	0.005
BL45	8.18	0.56	8.39	0.63	−4.362	0.000
MD46	10.70	0.61	10.96	0.65	−4.992	0.000
BL46	10.18	0.55	10.44	0.60	−5.513	0.000
MD47	9.92	0.62	10.26	0.66	−6.37	0.000
BL47	9.74	0.60	10.11	0.67	−7.055	0.000

4. Discussion

4.1. Intra-observer variation

The significant variation in the repeat measurement of two variables by observer I may be attributed to difficulties in measuring certain tooth dimensions[13]; a similar reason may be

Table 2
Stepwise logistic regression analyses of teeth in both jaws and single jaw.

Tooth variable	B	S.E.	Wald statistic	df	Sig.	Exp(B)
Both jaws						
MD13	0.673	0.276	5.949	1	0.015	1.961
BL16	0.635	0.222	8.173	1	0.004	1.887
MD25	−0.719	0.29	6.155	1	0.013	0.487
MD33	0.684	0.34	4.057	1	0.044	1.981
MD34	−1.072	0.336	10.202	1	0.001	0.342
MD35	−0.742	0.293	6.412	1	0.011	0.476
MD36	0.713	0.206	11.989	1	0.001	2.041
BL41	−0.612	0.196	9.725	1	0.002	0.542
MD42	−0.85	0.326	6.808	1	0.009	0.427
MD43	1.993	0.387	26.565	1	0.000	7.34
BL43	0.883	0.199	19.739	1	0.000	2.417
MD47	0.645	0.202	10.15	1	0.001	1.906
Constant	−24.386	2.93	69.289	1	0.000	0.000
Maxillary teeth						
MD13	0.529	0.311	2.896	1	0.089	1.698
BL13	0.597	0.185	10.425	1	0.001	1.817
BL16	0.686	0.196	12.293	1	0.000	1.985
MD17	0.37	0.144	6.587	1	0.01	1.448
MD22	−0.359	0.172	4.355	1	0.037	0.698
MD23	0.825	0.326	6.403	1	0.011	2.281
MD25	−0.841	0.25	11.287	1	0.001	0.431
Constant	−18.123	2.334	60.281	1	0.000	0.000
Mandibular teeth						
MD31	−0.699	0.305	5.258	1	0.022	0.497
MD33	0.837	0.338	6.151	1	0.013	2.31
MD34	−1.109	0.327	11.506	1	0.001	0.33
MD35	−0.842	0.284	8.778	1	0.003	0.431
MD36	0.75	0.197	14.528	1	0.000	2.117
BL41	−0.484	0.192	6.391	1	0.011	0.616
MD43	1.971	0.366	29.024	1	0.000	7.176
BL43	1.01	0.196	26.459	1	0.000	2.746
MD47	0.724	0.2	13.127	1	0.000	2.063
Constant	−20.953	2.649	62.577	1	0.000	0.000

attributed to the statistically different measurements obtained in repeat evaluations of observer III. However, considering that the mean differences for these variables were never more than 0.12 mm, the statistical differences may not translate to a major practical impact.

4.2. Univariate sexual dimorphism

Sexual dimorphism in tooth measurements has been evaluated for decades, with published reports on male–female odontometric differences available from various countries and diverse population groups.[17,18,25–31] Surprisingly, though, studies that have gauged sex differences in tooth size in South Asians in general, and Indians in particular, is a relatively recent phenomenon.

Rao et al.[32] reported sexual dimorphism in an Indian population more than twenty years ago, however, they only measured the MD dimension of mandibular canines. It was not until the last decade that studies examining all teeth were published. These, however, focused on relatively small sample sizes[10–13] and, interestingly, found lower degrees of sexual dimorphism when compared to European, Sub-Saharan African, Australian Aboriginal, and Native American populations. Two of these papers[11,13] also reported reverse sexual dimorphism, wherein some dimensions were, on the average, larger in females. Reverse dimorphism has also been reported in other populations, all of which examined a relatively small sample that ranged from 57 to 161 subjects.[28,29] (Readers are referred to these papers for additional details on why low and reverse sexual dimorphism may occur.)

On the contrary, the results of the present study reveal no reverse sexual dimorphism; in fact, it shows a great majority of variables (51/56, i.e., 91.1%) exhibiting statistically larger male teeth ($p < 0.05$). In a previous Indian study,[13] a mere 28.6% of variables were statistically larger in males, while 10 variables were larger in females albeit statistically insignificant ($p > 0.05$). This suggests that relatively large samples of Indians may reflect better the tendency of the male dentition to be larger than that of females. The percentage of statistically larger male teeth herein is higher than in the Nepalese (another South Asian country),[9,11] Tibetan,[30] as well as a West Asian sample.[28] However, the percentage is less than in Turks[17] and Australian Aborigines,[18] where virtually all male tooth variables were statistically larger than those of females.

Among the different tooth classes, the canines were the most sexually dimorphic. This is a finding echoed previously across populations.[11,13,17,18,28,31,33] The reasons for canines' preeminent position in dental sexual dimorphism have been discussed previously.[32] Briefly, it is considered to be an evolutionary remnant of aggressive function and threat in male primates. Today, this behavior has mostly been transferred to the arms and fingers in human males, but the important function which canines possessed through evolution is still reflected, to some extent, in men in the form of larger canines. In fact, Frayer and Wolpoff[34] have stated that sexual dimorphism seen in canines is unmatched in living and fossil anthropoid species.

The molars followed canines in terms of the degree of sexual dimorphism. Molars, particularly the first, have previously also been reported as being amongst the most sexually dimorphic human teeth.[15–17,30,35–37] One must add, though, that in the present Indian sample, the second molars were slightly more sexually dimorphic than the first (Table 1), which is similar to the findings in the Nepalese.[11]

4.3. Accuracy of stepwise logistic regression formulae

Although the BL tooth dimensions collectively revealed more univariate sexual dimorphism than the MD measurements, this did not translate to their greater contribution to the stepwise LRA (Table 2). In fact, four of the five variables that did not exhibit statistically significant univariate sexual dimorphism (Table 1) contributed to the multivariate analyses (Table 2). For example, the MD dimensions of the maxillary left lateral incisor (tooth 22) and second premolar (tooth 25), and mandibular left central incisor (tooth 31) and second premolar (tooth 35) entered either or both stepwise LRA in which they were considered (Table 2). It is not uncommon for teeth with statistically insignificant sexual dimorphism to enter multivariate analyses, or for teeth with statistically significant univariate dimorphism to not contribute to such analyses.[11,15] This has been attributed to multivariate analyses' ability to take into consideration tooth inter-relationships, thus enabling sexually 'non-dimorphic' tooth variables to contribute to sex assessment.[15]

The stepwise logistic regression formulae produced less accurate sex prediction in the test sample than in the reference sample used to derive the formulae (Table 3). This is unsurprising since one expects an element of bias in the allocation accuracy of the

Table 3
Classification results of the logistic regression analyses (LRA).

	Male		Female		Total	
	n	%	n	%	n	%
Accuracy on the same sample used to develop the model ($n = 600$)						
Teeth in both jaws	215/294	73.1	234/306	76.5	449/600	74.8
Maxillary teeth	198/294	67.3	215/306	70.3	413/600	68.8
Mandibular teeth	210/294	71.4	234/306	76.5	444/600	74.0
Accuracy on the test sample ($n = 69$)						
Teeth in both jaws	20/29	69.0	29/40	72.5	49/69	71.0
Maxillary teeth	17/29	58.6	30/40	75.0	47/69	68.1
Mandibular teeth	23/29	79.3	28/40	70.0	51/69	73.9

stepwise logistic regression formulae when applied to the same sample that was used to develop the formulae ($n = 600$); the very purpose of the use of a test sample ($n = 69$) is to avoid such a bias. Our results suggests that the stepwise logistic regression equations reported here may predict sex a little less accurately in forensic casework vis-à-vis the expected accuracy.

The stepwise LRA accuracy rates confirms previous reports of moderate accuracy levels in sex identification for Indians,[12,13] although it should be noted that our results are based on the more realistic allocation accuracy on a test sample. Based on this, odontometric sex identification is, at best, a supplemental method to other more accurate anatomical parameters such as the pelvic and craniofacial bones; it appears, therefore, that the 100% cross-validated allocation accuracy reported recently[14] is a rare exception, influenced perhaps by a small sample size. We recognize that the 100% sex identification accuracy reported[14] did not employ the stepwise method, rather, all tooth variables were entered; a similar analysis on the present sample resulted in only 75.5% correct allocation of sex. Therefore, the allocation accuracy levels is similar irrespective of the use of all tooth variables, or a stepwise analysis. Despite the moderate accuracy levels, however, the dentition can still be expected to find use and application in forensic, anthropological and archaeological cases owing to the ability of teeth to survive postmortem degradation and fragmentation, possible unavailability of other skeletal parameters, the ease and speed of obtaining tooth measurements, and the non-invasive nature of the method.

In conclusion, statistically significant univariate sex differences were observed in ~91% of tooth dimensions measured, while multivariate statistics allowed for correct sex identification in 68.8–74.8% of cases when the stepwise logistic regression formulae were applied to the sample used to develop the formulae [approach (1)]; when the same formulae were applied to a test sample [approach (4)], the sex identification accuracy decreased marginally (~68%–74%), particularly for both jaws taken together. Overall, the results, at best, may be considered as moderate in terms of accuracy, and are contrary to those which used LRA on a smaller heterogeneous Indian sample; this highlights the importance of sample size while drawing inferences on sex allocation accuracy, and suggests that teeth are suitable for sex identification in the people of this country only as a supplementary anatomical parameter.

Ethical approval

Ethics approval was obtained from the Ethical Committee of S.D.M. College of Dental Sciences & Hospital, Dharwad (Ethical Clearance dated 16th July 2007), and the Research and Ethical Committee of K.L.E. Society's Institute of Dental Sciences, Belgaum (Certificate dated 21 September 2009).

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Conflict of interest

None.

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